Incidence and Management of Bovine Claw Affections and Their Economic Impact: A Field Study on Dairy Farms

Ahmed, I. H. and Shekidef, M. H

Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Suez Canal University
shekidef77@vet.suez.edu.eg

Abstract: This field study aimed at improving claw health in dairy herds through early diagnosis and convenient treatment. Whereas, the objective of the data analysis was to estimate the association of the hoof lesions detected at different stages of lactation with the milk produced on test days by Holsteins Frisian cows in Egyptian dairy farms. The original data included 1312 cows from 3 farms in Egypt between January 2008 and December 2009. The lesions were aggregated by etiology. Sole abscess (SA) and sole ulcer (SU) were aggregated as hoof horn diseases (HHD). Digital dermatitis (DD) was maintained as a separate outcome and the lesions Interdigital dermatitis (ID), heel horn erosions (HHE), interdigital hyperplasia (IH) and interdigital phlegmon (IP) were aggregated as other infectious diseases (OID). Wound at interdigital skin (WD) and fracture of 3rd phalanx (FR) were aggregated into accidental lesions (AL). Hoof lesions were categorized by lactation stage at detection to allow comparison of outcomes between cows with lesions identified early in lactation and those identified later. Prevalence of the lesions as well as TDY was recorded. The results revealed that, SU and SA have the highest prevalence among the hoof lesions. They are usually associated with the greatest milk loss as well. High yielding dairy cows are more likely to expose to lameness due to SA and SU than average yielding or low yielding cows. DD, OID or accidental hoof lesions can affect dairy cows regardless their milk yield. Primiparous cows are more prone to be affected with higher prevalence of hoof lesions than multiparous cows due to physiological alteration associated with the first exposure to pregnancy and lactation.
[Ahmed, I. H. and Shekidef, M. H **Incidence and Management of Bovine Claw Affections and Their Economic Impact: A Field Study on Dairy Farms]** Journal of American Science 2012;8(6):46-61].(ISSN: 1545-1003). http://www.americanscience.org. 6

Keywords: Dairy cows; Lameness; Milk yield; Claw lesions.

1. Introduction

Lameness in dairy cows is a serious welfare issue. It is a painful condition and causes economic losses ***(Esslemont and Kossaibati, 1997)*** through early culling ***(Booth et al., 2004)*** and reduced milk yield ***(Amory et al., 2008)***. Meanwhile, the ultimate cost of a case of lameness is substantially greater than treatment cost alone. In the pathogenesis of claw lesions are involved herd-level factors such as housing environment, management practices and nutrition, as well as cow-level factors including parity, stage of lactation, body weight and genetics ***(Vermunt and Greenough, 1994)***.

Claw disorders can be aggregated into three main categories according to their etiology; infectious/partly infectious, metabolic/mechanical and traumatic ***(Greenough and Weaver 1997)***. Infectious and partly infectious claw lesions as dermatitis, heel-horn erosions and interdigital phlegmones are mainly influenced by the environment. Hemorrhages of the sole and the white line, sole ulcers and white-line fissures have been aggregated into "claw-horn disruption" ***(Lischer et al., 2002)***. Important traumatic injuries are pedal bone fractures and traumas to the sole and interdigital space by foreign bodies ***(Amory et al., 2008)***.

A number of studies have reported that higher yielding cows are more likely to become lame ***(Dohoo and Martin, 1984; Rowlands and Lucey, 1986; Barkema et al., 1994; Green et al., 2002; Ettema et al., 2007*** and ***Amory et al., 2008)***. These lame cows might produce absolutely less milk than unaffected cows ***(Tranter and Morris, 1991; Warnick et al., 2001; Hernandez et al., 2002*** and ***Amory et al., 2008)*** or less milk than their potential as demonstrated by ***Green et al. (2002)***.

The relation of hoof lesions with milk production is a difficult one to study because a high milk yield level is known to be a risk factor for hoof lesions and at the same time hoof lesions are known to reduce the cow's milk production ***(Amory et al., 2008)***. ***Green et al. (2002)*** found a milk loss between 160 and 550 kg per lactation for cows with a form of clinical lameness. ***Warnick et al. (2001)*** reported a milk loss between 104 and 295 kg per lactation for cows that became lame at 100 days in milk (DIM). ***Green et al. (2002)*** also qualified milk production level as a risk factor for lameness in their study; on days that these cows were not lame, they produced a mean increased milk yield of 1.12 kg compared to cows that were never lame. A comparable result was found in a cross-sectional study by ***Hultgren et al. (2004)*** who studied the association between the occurrence of sole ulcers and the total milk yield per lactation. Milk yield is therefore not

only important as an effect of hoof lesions but also as a risk factor.

Few studies have differentiated the lesion-specific cause of lameness when estimating milk loss. ***Hernandez et al. (2002)*** studied 531 cows in one herd in the USA, where cows that were lame with interdigital phlegmon produced significantly less milk over a lactation than unaffected cows (7767 kg vs. 8622 kg, respectively), with no significant milk loss attributable to other foot lesions. In a study of two farms, ***Warnick et al. (2001)*** reported that on one farm cows that were lame with a sole ulcer (SU) had the greatest loss of milk, followed by sole and white line abscesses and then interdigital phlegmon with no significant effect of foot warts (digital dermatitis). However, there were no lesion-specific associations with reduced milk yield on the second farm. In addition, ***Amory et al. (2008)*** reported that, high yielding dairy cows, on 30 dairy farms, were more likely to become clinically lame with SU or WLD than unaffected cows, whilst cattle that were affected with (digital dermatitis) DD or 'other' causes of lameness were not higher yielding than unaffected cows. Farmer diagnosis of SU and WLD were associated with significant milk loss. For example, cows diagnosed with either SU or WLD at 5 months in milk were associated with a mean decreased yield per lactation of 574 kg and 369 kg respectively. Digital dermatitis or the presence of any 'other' lesion was not associated with economically significant reduction in milk production.

The aim of the work

The overall purpose of this field study performed on three farms during the period between January, 2008 and December, 2009 was to improve claw health in Egyptian dairy herds through early diagnosis and convenient treatment. The objective of the data analysis was to estimate the association of the hoof lesions detected at different stages of lactation with the milk produced on test days by Holsteins Frisian cows in Egyptian dairy farms.

2. Materials and Methods

The original data included 1312 cows from 3 farms in Egypt. The dataset was collected from January 2008 to December 2009. The farms were similar in feeding and automatic milking systems. The cows in the farms were kept outdoor on sandy floor.

Lesions causing clinical lameness were recorded by veterinarians resident in the farms who used a reference sheet with illustrations and descriptions of the lesions to assist with lesion recognition. On the recording form the veterinarians named the lesion and marked the location on a diagram of a foot.

According ***Ettema and Østergaard (2006)***, the lesions, in this study, were aggregated by etiology. Sole abscess (SA) and sole ulcer (SU) were aggregated as hoof horn diseases (HHD). DD was maintained as a separate outcome and the lesions ID, HHE, IH and IP were aggregated as other infectious diseases (OID). Wound at interdigital skin (WD) and compound fracture of 3rd phalanx with septic podoarthritis (FR) were both recognized during examination by veterinarians. These lesions were accidentally occurred after trauma so they were mentioned in a separate aggregation, accidental lesions (AL) and were included in the dataset.

Lesions and abnormalities were evaluated during the daily observation by the resident veterinarians. Multiple different lesion types on the same cow were registered when they were present. Besides identification, all lesions got the usual treatment; curative trimming, bandage, cleaning and/or dressing with disinfecting products depending on the type of lesion. Claw amputation was performed in cases with unfavorable prognosis.

Hoof lesions were categorized by lactation stage at detection to allow comparison of outcomes between cows with lesions identified early in lactation and those identified later. Each hoof lesion variable was categorized as follows: 1 = identified in the first 100 days in milk; 2 = identified between 101 and 200 days in milk; 3 = identified between 201 and 300 days in milk and 4 = identified after 300 days in milk. This scale was modified from the study of ***Ettema et al. (2007)***. They had categorized hoof lesion variables into four stages; 0, 1, 2 and 3; where 0 = not identified and 3 = identified between 201 and 305 DIM. Instead, in our study, hoof lesion variables were categorized into 1, 2, 3 and 4; where 4 = identified after 300 DIM. The reason for the extension of the DIM period in this study was that the 4^{th} stage was including considerable number of cows those were not inseminated in the optimum time and those did not conceive despite their insemination.

Information on breed, calving number and milk production was obtained from the farm records. In addition, calving date, insemination date and conception date, were all also obtained from the farm records to estimate the reproductive status of the cows at the test day. Administrative errors that were made during on-farm recording made it impossible to retrieve any information on 136 cows, for this reason they were not included in the analysis and the total herd number became only 1176 cows.

Data analysis

The information recorded at the three farms was transferred to SPSS® version 19.0 for statistical analysis. The herd prevalence of lameness was expressed as the percentage of lame cows to the total herd number and the herd prevalence of each claw lesion was expressed as the percentage of lame animals

that had the specific lesion to the total herd as well. In addition, regarding to the reproductive status of the affected cows, the prevalence of the hoof lesions in heifers (primiparous cows) and multiparous cows was also expressed as percentage to the total number of primiparous and multiparous cows respectively.

The first lactation is considered the most tumultuous period of the cow's life in which she undergoes many changes and much is physiologically demanded of her ***(Ettema et al., 2007)***. For this reason, the analysis on TDY in this study was done separately for the primiparous cows and the multiparous cows. The dataset for the former included 378 cows of which 292 conceived within 300 days and another 86 after 300 days. The multiparous dataset included 798 cows of which 729 conceived within 300 days and another 69 after 300 days.

Separately for heifers and multiparous cows, SPSS version 19.0 was used to perform repeated measurements analysis of variance and to apply Tukey test for multiple comparisons to study the association between the hoof lesions and mean TDY. Mean TDY of the unaffected cows in the same lactation period was considered the objective data to base the comparison on.

3. Results

Descriptive statistics

Prevalence of hoof lesions within early (<100 DIM), mid (101–200 DIM) and late (201-300 DIM) stages of lactation, as well as, after 300 DIM are shown in Table 1. Prevalence of DD, HHD, OID and AL are presented along with the separate diseases that are aggregated into them.

Herd size and lesion rates for the 3 farms are presented in Table 1. Out of the 1176 cows in the study, 414 (35.2%) were lame with at least one lesion. There were 39 diagnoses of DD, 75 of SA (89.3% lateral and 10.7% medial), 168 of SU (88.7% lateral and 11.3% medial), 9 of HHE (77.8% lateral and 22.2% medial), 60 of ID, 27 of IH, 9 of IP and 24 of accidental lesions (18 of wound at interdigital skin and 6 of fracture of the 3rd phalanx with septic podarthritis). 25% cows had at least one repeat of the same lesion in the lactation. The rate of SA, HHE and ID peaked at the 3rd lactation stage while SU and IH peaked at the 2nd lactation stage. The rate of DD peaked in both 2nd and 3rd stages. The accidental lesions were recorded only in 1st and 2nd lactation stages. The prevalence of all aggregated hoof lesions increased from the first stage of lactation towards the later stages. Out of the four aggregated lesions, HHD had the highest prevalence. Accidental hoof lesions were represented in the 1st and 2nd stages only (Fig. 1).

Herd size and lesion rates in primiparous and multiparous cows are presented in Table 2. Out of the 378 primiparous cows in the study, 195 (51.59%) were lame with at least one lesion. There were 18 diagnoses of DD (4.76%), 26.98% of HHD (2.38% of SA and 24.60% of SU), 17.60% of OID (1.59% of HHE, 10.32% of ID, 4.76% of IH and 0.79% of IP) and 2.38% of wound at interdigital skin, while, fracture of the 3rd phalanx was not recorded in primiparous cows in this study. On the other hands, 219 (27.44%) of the 798 multiparous cows were lame. There were 21 diagnoses of DD (2.63%), 18.05% of HHD (8.65% of SA and 9.40% of SU), 4.89% of OID (0.38% of HHE, 2.63% of ID, 1.13% of IH and 0.75% of IP) and 1.88% of accidental lesions (1.13% of wound and 0.75% fracture of the 3rd phalanx). The prevalence of all separate hoof lesions except sole abscess and fracture of the 3rd phalanx was relatively higher in primiparous cows than that of multiparous ones, while the prevalence of all aggregated hoof lesions was higher in primiparous cows than that of multiparous ones (Fig 2).

Description of the diagnosed lesions

The diagnosed ID cases were characterized by epidermal thickening and were seen in the dorsal (11%), plantar (79%) or palmar (24%) interdigital clefts (Fig. 3). In five cases, HHE was found in accompany with ID and three cases developed fissures of heel horn (Fig. 4).

IH or so called interdigital vegetative dermatitis appeared in the form of epidermal vegetation of the interdigital skin. The outer claw of the hind leg was most affected (83%), where it started on a small skin fold close to the wall of the outer claw (Fig. 5). In most cases (69%), it was associated with ID.

IP (cellulitis) of the interdigital and digital tissues was seen in the form of symmetrical red and painful swelling of the foot (Fig. 6A). It caused severe lameness in the affected cows. A break in the interdigital skin was present in approximately 70% of the cases, containing necrotic tissue (Fig. 6B).

The lesions of DD found mostly (70%) on the skin of the plantar aspect adjacent to the interdigital cleft (Fig. 7A). In nine cases (22.5%), the lesion was found at the skin–horn junction of the heel bulbs (Fig. 7B). Only three cases (7.5%) had the lesion bordering the dorsal interdigital cleft of the fore feet (Fig. 7C). Chronic digital dermatitis lesion with filiform papillae (papillomatous form) was observed in one case (Fig. 7D). In all DD affected cases, cows had altered their posture and gait to avoid direct contact between lesions and the floor due to pain.

Affected cows of sole ulcer showed different degrees of lameness in an effort to place more weight on the medial claws. 11% of the affected cases with sole ulcer showed hemorrhage (Fig. 8A) at the sole ulcer site without an open horn defect while 89% of the affected cases showed damage in the surface of the horn around the ulcer site (Fig. 8B).

Most diagnosed cases (92%) of sole abscess or so called subsolar abscess were present in association with sole ulcers but in the minority of cases (6 cases, 8%), foreign body penetration was the cause. The full thickness of the solar horn was found to be separated from the underlying solar corium and the space thus created was filled with pus. Pus was observed to be come out through a defect in the solar horn (Fig. 9).

The convenient treatment protocol for each lesion was initiated by the authors, as well as, the duty of the follow up was committed also to them in regular visits. The lameness did not completely disappear before at least two weeks from the start of the treatment. Cows affected with fracture of the pedal bone with septic podarthritis, HHD and OID especially IP showed more delay in relief of lameness than those affected with other lesions.

Associations with test-day milk yields

The results of the analyses of variance and Tukey test for multiple comparisons between means of TDY are displayed in Table (3) and (4) for primiparous cows and Table (5) and (6) for multiparous cows. Minimum and maximum TDY as well as, lower and upper bound of the confidence interval for mean differences are omitted from the tables to limit the table size. Baseline for comparison is mean TDY of the cows, in the same lactation stage, without diagnosed hoof lesions.

In primiparous cows, the separate lesions in different stages of lactation were associated with TDY (Table 5). There were significant decreases in mean TDY in cows suffered from SU in the 2nd and 4th lactation stages and ID and IH in the 4th lactation stage. Cows that were diagnosed with SU in the 2nd and 4th lactation stage produced approximately 9 kg and 12 kg less milk respectively in the test day than unaffected cows in the same stages. Similarly, cows that were diagnosed with ID and IH produced approximately 12 kg and 20.5 kg less milk respectively than unaffected cows in the 4th lactation stage.

In primiparous cows, the aggregated lesions in different stages of lactation were associated with TDY (Table 6). There were significant decreases in mean TDY in cows suffered from HHD in the 2nd and 4th lactation stages and OID in the 4th lactation stage. Cows that were diagnosed with HHD in the 2nd and 4th lactation stage produced approximately 8.5 kg and 12 kg less milk respectively in the test day than unaffected cows in the same stages. Similarly, cows that were diagnosed with OID produced approximately 15 kg less milk than unaffected cows in the 4th lactation stage. Cows with DD and other accidental lesions causing lameness were not associated with significant change in milk yield than non-lame cows.

In multiparous cows, the separate lesions in different stages of lactation were associated with TDY (Table 7). There were significant decreases in mean TDY in cows suffered from SA and SU all over the lactation stages; and ID in the 3rd and 4th stages. Cows that were diagnosed with DD and HHE showed significant decrease in TDY in the 3rd lactation stage, while those were diagnosed with fracture of os pedis, IH and IP showed significant decreases in the 1st, 2nd and 4th stage respectively. The highest mean difference was recorded between unaffected and cows suffered from HHE in the 3rd lactation stage (approximately 27 kg).

In multiparous cows, the aggregated lesions in different stages of lactation were associated with TDY (Table 8). There were significant decreases in mean TDY in cows suffered from HHD all over the lactation stages and OID in the 2nd, 3rd and 4th lactation stages. Cows that were diagnosed with DD showed significant decreases in TDY in the 3rd and 4th lactation stages, while, those suffered from accidental lesions showed significant decrease in the 1st lactation stage.

Although we compared mean TDY between affected and normal (unaffected) cows we had noticed that the affected cows with SA and SU had a history (from previous farm records) of being the highest producers in the herd. Other hoof lesions, in this study, had the affinity to affect the claws of the cows regardless their milk yield. The milk production of the affected cows started to improve by the 3rd week post treatment protocol.

Fig (1): Prevalence of aggregated hoof lesions divided in stages of lactation; before 100 DIM, between 101 and 200 DIM, between 201 and 300 DIM and after 300 DIM.

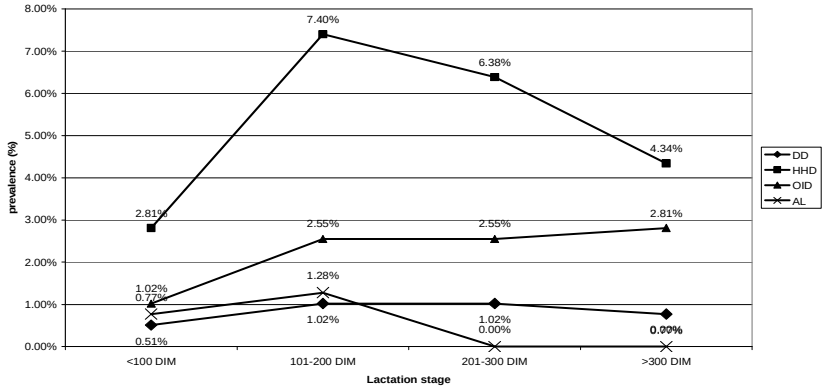

Fig. (2): Prevalence of aggregated hoof lesions in primiparous and multiparous cows.

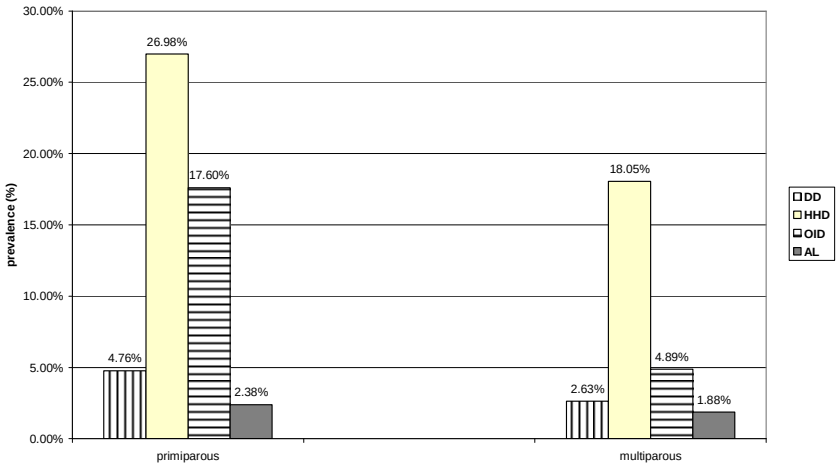

Fig. (3): A plantar surface of a cow's hind limb showing ID in the interdigital cleft.

Fig. (4): A plantar surface of a cow's hind limb showing heel horn erosions in the form of horn fissure accompanying ID.

Fig. (5): A ground surface of a cow's claw showing a small skin fold close to the wall of the outer claw representing a case of IH.

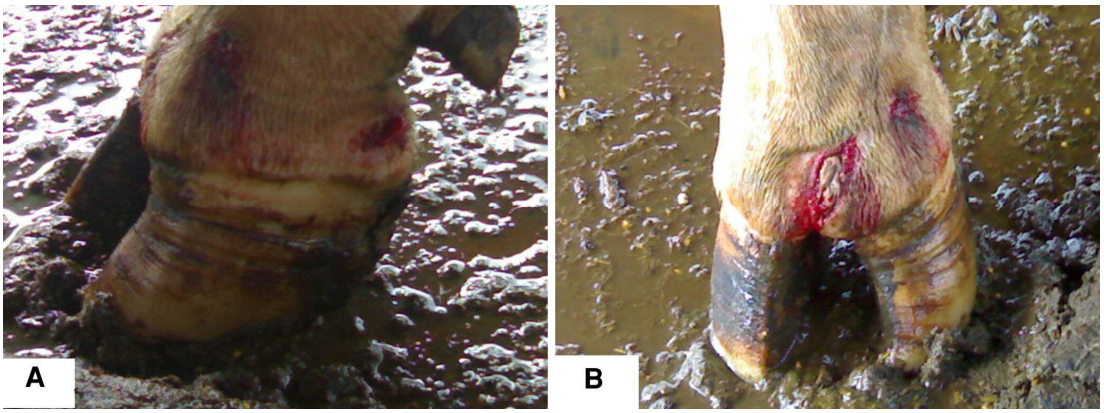

Fig. (6); An IP in a cow's hind limb (A) symmetrical swelling of the foot, (B) A break in the interdigital skin containing necrotic tissue.

Fig. (7): Different forms of DD in cow's foot (A) The lesion is found on the skin of the plantar aspect adjacent to the interdigital cleft. (B) The lesion is found at the skin–horn junction of the heel bulbs**.** (C) The lesion bordering the dorsal interdigital cleft of the fore feet**.** (D) Chronic digital dermatitis lesion with filiform papillae (papillomatous form) is observed near the dorsal interdigital cleft.

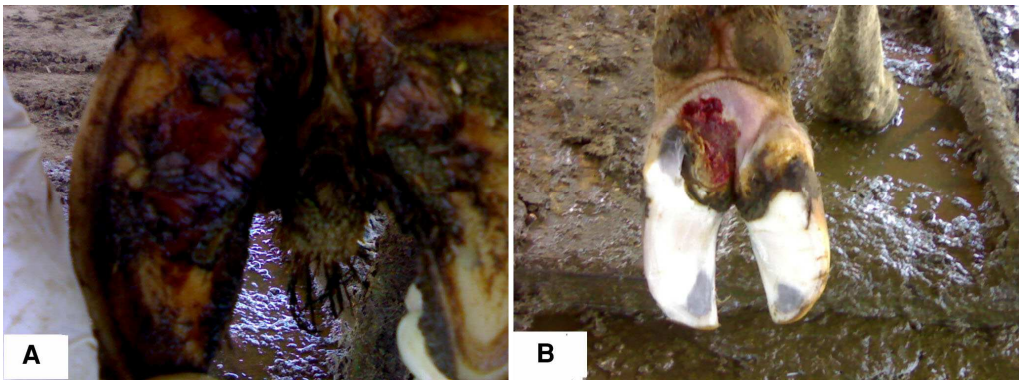

Fig. (8): Two cows affected with sole ulcer (A) One case to the left is showing hemorrhage at the sole ulcer site without an open horn defect while (B) the second one to the right is showing a damage in the surface of the horn around the ulcer site.

Fig. (9): A case of sole abscess showing that the full thickness of the solar horn is found to be separated from the underlying solar corium and the space thus created is filled with pus. Pus was observed to be come out through a defect in the solar horn (arrow).

Table (1): Overall prevalence of hoof lesions (All) and divided in stages of lactation; before 101 DIM, between 101 and 200 DIM, between 201 and 300 DIM and after 301 DIM (n=1176).

Hoof Lesions	All		<100 DIM		101-200 DIM		201-300 DIM		>300 DIM	
	N	%	N	%	N	%	N	%	N	%
DD	39	3.32%	6	0.51%	12	1.02%	12	1.02%	9	0.77%
HHD	246	20.92%	33	2.81%	87	7.40%	75	6.38%	51	4.34%
SA	75	6.38%	12	1.02%	15	1.28%	33	2.81%	18	1.53%
SU	168	14.29%	21	1.79%	72	6.12%	42	3.57%	33	2.81%
OID	105	8.93%	12	1.02%	30	2.55%	30	2.55%	33	2.81%
HHE	9	0.77%	0	0.00%	0	0.00%	6	0.51%	3	0.26%
ID	60	5.10%	9	0.77%	12	1.02%	21	1.79%	18	1.53%
IH	27	2.30%	0	0.00%	15	1.28%	3	0.26%	9	0.77%
IP	9	0.77%	3	0.26%	3	0.26%	0	0.00%	3	0.26%
AL	24	2.04%	9	0.77%	15	1.28%	0	0.00%	0	0.00%
WD	18	1.53%	3	0.26%	15	1.28%	0	0.00%	0	0.00%
FR	6	0.51%	6	0.51%	0	0.00%	0	0.00%	0	0.00%
Total affected	414	35.20%	60	5.10%	144	12.24%	117	9.95%	93	7.91%
Total number	1176	100%	195	16.58%	363	30.87%	330	28.06%	288	24.49%

The percentages per stage of lactation represent the % of all cows positively diagnosed with specified lesions to the total cow's number (n=1176).

Table (2): Prevalence of hoof lesions in primiparous (n=378 "32.14% of total herd") and multiparous (n=798 "67.86% of total herd") cows (All) and divided in stages of lactation.

	Primiparous		Multiparous	
Hoof lesions	**Number**	**Percentage**	**Number**	**Percentage**
Digital dermatitis	**18**	**4.76%**	**21**	**2.63%**
<100 DIM	0	0.00%	6	0.75%
101-200 DIM	9	2.38%	3	0.38%
201-300 DIM	3	0.79%	9	1.13%
>300 DIM	6	1.59%	3	0.38%
Hoof horn diseases	**102**	**26.98%**	**144**	**18.05%**
<100 DIM	15	3.97%	18	2.26%
101-200 DIM	42	11.11%	45	5.64%
201-300 DIM	15	3.97%	60	7.52%
>300 DIM	30	7.94%	21	2.63%
Sole abscess	**9**	**2.38%**	**69**	**8.65%**
<100 DIM	3	0.79%	9	1.13%
101-200 DIM	3	0.79%	12	1.50%
201-300 DIM	3	0.79%	30	3.76%
>300 DIM	0	0.00%	18	2.26%
Sole ulcer	**93**	**24.60%**	**75**	**9.40%**
<100 DIM	12	3.17%	9	1.13%
101-200 DIM	39	10.32%	33	4.14%
200-300 DIM	12	3.17%	30	3.76%
>300 DIM	30	7.94%	3	0.38%
Other infectious diseases	**66**	**17.60%**	**39**	**4.89%**
<100 DIM	6	1.59%	6	0.75%
101-200 DIM	24	6.35%	9	1.13%
201-300 DIM	15	3.97%	12	1.50%
>300 DIM	21	5.56%	12	1.50%
Heel horn erosion	**6**	**1.59%**	**3**	**0.38%**
<100 DIM	0	0.00%	0	0.00%
101-200 DIM	0	0.00%	0	0.00%
201-300 DIM	3	0.79%	3	0.38%
>300 DIM	3	0.79%	0	0.00%
Interdigital dermatitis	**39**	**10.32%**	**21**	**2.63%**
<100 DIM	6	1.59%	3	0.38%
101-200 DIM	12	3.17%	3	0.38%
201-300 DIM	12	3.17%	6	0.75%
>300 DIM	9	2.38%	9	1.13%
Interdigital hyperplasia	**18**	**4.76%**	**9**	**1.13%**
<100 DIM	0	0.00%	0	0.00%
101-200 DIM	9	2.38%	6	0.75%
201-300 DIM	0	0.00%	3	0.38%
>300 DIM	9	2.38%	0	0.00%
Intrdigital phlegmone	**3**	**0.79%**	**6**	**0.75%**
<100 DIM	0	0.00%	3	0.38%
101-200 DIM	3	0.79%	0	0.00%
201-300 DIM	0	0.00%	0	0.00%
>300 DIM	0	0.00%	3	0.38%
Accidental	**9**	**2.38%**	**15**	**1.88%**
<100 DIM	3	0.79%	6	0.75%
101-200 DIM	6	1.59%	9	1.13%
201-300 DIM	0	0.00%	0	0.00%
>300 DIM	0	0.00%	0	0.00%
Wound	**9**	**2.38%**	**9**	**1.13%**
<100 DIM	3	0.79%	0	0.00%
101-200 DIM	6	1.59%	9	1.13%
201-300 DIM	0	0.00%	0	0.00%
>300 DIM	0	0.00%	0	0.00%
Fracture	**0**	**0.00%**	**6**	**0.75%**
<100 DIM	0	0.00%	6	0.75%
101-200 DIM	0	0.00%	0	0.00%
201-300 DIM	0	0.00%	0	0.00%
>300 DIM	0	0.00%	0	0.00%
Total affected	**195**	**51.59%**	**219**	**27.44%**
Total number	**378**	**32.14%**	**798**	**67.86%**

Table (3): Associations of separate hoof lesions at test day with test-day yield in different lactation stages for primiparous cows (n=378).

Lactation stage	N	Mean TDY	Std. Error	95% Confidence Interval for Mean		Difference from TDY of normal cows at the same lactation stage	
				Lower Bound	Upper Bound	Mean difference	*P* value
Unaffected cows							
<100 DIM	39	25.46	1.57	34.47	40.78		
101-200 DIM	39	35.15	0.42	35.43	37.10		
201-300 DIM	24	28.50	1.15	32.15	36.76		
>300 DIM	81	26.78	1.08	24.63	28.93		
Wound at interdigital skin							
<100 DIM	3	25.33	1.76	17.74	32.92	0.13	1.000
101-200 DIM	6	27.50	2.01	22.33	32.67	7.65	0.937
201-300 DIM	0	-	-	-	-	-	-
>300 DIM	0	-	-	-	-	-	-
Digital dermatitis							
<100 DIM	0	-	-	-	-	-	-
101-200 DIM	9	25.67	2.62	19.63	31.71	9.49	0.303
201-300 DIM	3	29.67	2.33	19.63	39.71	-1.17	1.000
>300 DIM	6	16.33	5.21	2.93	29.73	10.44	0.380
Sole abscess							
<100 DIM	3	32.67	1.45	26.42	38.92	-7.21	1.000
101-200 DIM	3	35.00	1.15	30.03	39.97	0.15	1.000
201-300 DIM	3	31.33	0.88	27.54	35.13	-2.83	1.000
>300 DIM	0	-	-	-	-	-	-
Sole ulcer							
<100 DIM	12	29.00	0.56	27.76	30.24	-3.54	1.000
101-200 DIM	39	26.08	1.34	23.36	28.79	9.08*	0.001
201-300 DIM	12	20.75	3.66	12.69	28.81	7.75	0.633
>300 DIM	30	14.70	1.15	12.35	17.05	12.08*	0.000
Heel horn erosions							
<100 DIM	0	-	-	-	-	-	-
101-200 DIM	0	-	-	-	-	-	-
201-300 DIM	3	24.67	0.88	20.87	28.46	3.83	1.000
>300 DIM	3	18.67	1.76	11.08	26.26	8.11	0.996
Interdigital dermatitis							
<100 DIM	6	32.00	4.02	21.65	42.35	-6.54	0.990
101-200 DIM	12	27.75	1.19	25.12	30.38	7.40	0.586
201-300 DIM	12	20.00	2.76	13.94	26.06	8.50	0.437
>300 DIM	9	14.67	1.86	10.39	18.95	12.11*	0.014
Interdigital hyperplasia							
<100 DIM	0	-	-	-	-	-	-
101-200 DIM	9	29.00	1.50	25.54	32.46	6.15	0.962
201-300 DIM	0	-	-	-	-	-	-
>300 DIM	9	6.33	3.17	-0.97	13.64	20.44*	0.000
Interdigital phlegmone							
<100 DIM	0	-	-	-	-	-	-
101-200 DIM	3	32.67	0.88	28.87	36.46	2.49	1.000
201-300 DIM	0	-	-	-	-	-	-
>300 DIM	0	-	-	-	-	-	-
Total affected	195	22.84	0.71	21.44	24.24		
Total number	378	29.40	0.49	28.44	30.35		

Table (4): Associations of aggregated hoof lesions at test day with test-day yield in different lactation stages for primiparous cows (n=378).

Lactation stage	N	Mean	Std. Error	95% Confidence Interval for Mean		Difference from TDY of normal cows at the same lactation stage	
				Lower Bound	Upper Bound	Mean difference	*P* value
Unaffected cows							
<100 DIM	39	25.46	1.57	34.47	40.78		
101-200 DIM	39	35.15	0.42	35.43	37.11		
201-300 DIM	24	28.50	1.15	32.15	36.76		
>300 DIM	81	26.78	1.08	24.63	28.93		
Accidental lesions							
<100 DIM	3	25.33	1.76	17.74	32.92	0.13	1.000
101-200 DIM	6	27.50	2.01	22.33	32.67	7.65	0.829
201-300 DIM	0	-	-	-	-	-	-
>300 DIM	0	-	-	-	-	-	-
Digital dermatitis							
<100 DIM	0	-	-	-	-	-	-
101-200 DIM	9	25.67	2.62	19.63	31.71	9.49	0.195
201-300 DIM	3	29.67	2.33	19.63	39.71	-1.17	1.000
>300 DIM	6	16.33	5.21	2.93	29.73	10.44	0.252
Hoof horn diseases							
<100 DIM	15	29.73	0.64	28.35	31.11	-4.27	0.969
101-200 DIM	42	26.71	1.30	24.10	29.33	8.44*	0.002
201-300 DIM	15	22.87	3.12	16.17	29.56	5.63	0.850
>300 DIM	30	14.70	1.15	12.35	17.05	12.08*	0.000
Other infectious diseases							
<100 DIM	6	32.00	4.02	21.65	42.35	-6.54	0.948
101-200 DIM	24	28.83	0.87	27.04	30.62	6.32	0.273
201-300 DIM	15	20.93	2.25	16.12	25.75	7.57	0.374
>300 DIM	21	11.67	1.87	7.76	15.57	15.11*	0.000
Total affected	195	22.84	0.71	21.44	24.24		
Total number	378	29.40	0.49	28.44	30.35		

Table (5): Associations of separate hoof lesions at test day with test-day yield in different lactation stages for multiparous cows (n=798).

Lactation stage	N	Mean	Std. Error	95% Confidence Interval for Mean		Difference from TDY of normal cows at the same lactation stage	
				Lower Bound	Upper Bound	Mean difference	*P* value
Unaffected cows							
<100 DIM	96	40.31	1.59	32.39	38.72		
101-200 DIM	180	37.68	0.37	37.15	38.63		
201-300 DIM	189	36.54	0.57	35.04	37.28		
>300 DIM	114	25.79	0.90	24.01	27.57		
Fracture of os pedis with septic podarthritis							
<100 DIM	6	12.33	0.42	11.25	13.42	27.98*	0.000
101-200 DIM	0	-	-	-	-	-	-
201-300 DIM	0	-	-	-	-	-	-
>300 DIM	0	-	-	-	-	-	-
Wound at interdigital skin							
<100 DIM	0	-	-	-	-	-	-
101-200 DIM	9	35.00\	2.75	28.65	41.35	2.68	1.000
201-300 DIM	0	-	-	-	-	-	-
>300 DIM	0	-	-	-	-	-	-
Digital dermatitis							
<100 DIM	6	34.83	3.65	25.46	44.21	5.48	0.999
101-200 DIM	3	31.33	0.88	27.54	35.13	6.35	1.000
201-300 DIM	9	23.33	3.09	16.22	30.45	13.21*	0.001
>300 DIM	3	8.33	1.45	2.08	14.58	17.46	0.062
Sole abscess							
<100 DIM	9	25.33	3.42	17.45	33.22	14.98*	0.000
101-200 DIM	12	23.25	4.15	14.11	32.39	14.43*	0.000
201-300 DIM	30	27.50	1.33	24.78	30.22	9.04*	0.000

>300 DIM	18	16.67	2.64	11.10	22.23	9.12*	0.004
Sole ulcer							
<100 DIM	9	24.33	2.20	19.25	29.42	15.98*	0.000
101-200 DIM	33	31.45	1.66	28.08	34.83	6.23*	0.017
201-300 DIM	30	21.70	1.52	18.60	24.80	14.84*	0.000
>300 DIM	3	7.00	3.61	-8.51	22.51	18.79*	0.024
Heel horn erosions							
<100 DIM	0	-	-	-	-	-	-
101-200 DIM	0	-	-	-	-	-	-
201-300 DIM	3	9.67	1.20	4.50	14.84	26.87*	0.000
>300 DIM	0	-	-	-	-	-	-
Interdigital dermatitis							
<100 DIM	3	34. 67	0.88	30.87	38.46	5.65	1.000
101-200 DIM	3	23.67	0.88	19.87	27.46	14.02	0.385
201-300 DIM	6	20.00	0.45	18.85	21.15	16.54*	0.000
>300 DIM	9	9.00	3.12	1.80	16.20	16.79*	0.000
Interdigital hyperplasia							
<100 DIM	0	-	-	-	-	-	-
101-200 DIM	6	18.67	5.97	3.32	34.01	19.02*	0.000
201-300 DIM	3	30.67	1.20	25.50	35.84	5.87	1.000
>300 DIM	0	-	-	-	-	-	-
Interdigital phlegmon							
<100 DIM	3	36.67	0.67	33.80	39.56	3.65	1.000
101-200 DIM	0	-	-	-	-	-	-
201-300 DIM	0	-	-	-	-	-	-
>300 DIM	3	7.00	3.61	-8.51	22.51	18.79*	0.024
Total affected	219	23.87	0.77	22.36	25.38		
Total number	798	30.62	0.48	29.74	31.50		

Table (6): Associations of aggregated hoof lesions at test day with test-day yield in different lactation stages for multiparous cows (n=798).

Lactation stage	N	Mean	Std. Error	95% Confidence Interval for Mean		Difference from TDY of normal cows at the same lactation stage	
				Lower Bound	Upper Bound	Mean difference	*P* value
Unaffected cows							
<100 DIM	96	40.31	1.59	32.39	38.72		
101-200 DIM	180	37.68	0.37	37.15	38.63		
201-300 DIM	189	36.54	0.57	35.04	37.29		
>300 DIM	114	25.79	0.90	24.01	27.57		
Accidental lesions							
<100 DIM	6	12.33	0.42	11.25	13.42	27.98*	0.000
101-200 DIM	9	35.00	2.75	28.65	41.35	2.68	1.000
201-300 DIM	0	-	-	-	-	-	-
>300 DIM	0	-	-	-	-	-	-
Digital dermatitis							
<100 DIM	6	34.83	3.65	25.46	44.21	5.48	0.985
101-200 DIM	3	31.33	0.88	27.54	35.13	6.35	0.998
201-300 DIM	9	23.33	3.09	16.22	30.45	13.21*	0.001
>300 DIM	3	8.33	1.45	2.08	14.59	17.47*	0.037
Hoof horn diseases							
<100 DIM	18	24.83	1.98	20.66	29.01	15.48*	0.000
101-200 DIM	45	29.27	1.71	25.83	32.71	8.42*	0.000
201-300 DIM	60	24.60	1.07	22.46	26.74	11.94*	0.000
>300 DIM	21	15.29	2.41	10.25	20.32	10.50*	0.000
Other infectious diseases							
<100 DIM	6	35.67	0.67	33.95	37.38	4.65	0.998
101-200 DIM	9	20.33	3.95	11.22	29.45	17.35*	0.000
201-300 DIM	12	20.08	2.28	15.07	25.10	16.46*	0.000
>300 DIM	12	8.50	2.45	3.12	13.88	17.29*	0.000
Total affected	219	23.87	0.77	22.36	25.39		
Total number	798	32.24	0.40	31.46	33.02		

4. Discussion

According to *Ettema and Ostergaard (2006)*, the lesions in this study were aggregated by etiology. The lesions sole abscess (SA) and sole ulcer (SU) were aggregated as hoof horn diseases (HHD). These lesions are all associated with disturbed horn growth and are believed to be related to nutritional and metabolic disorders, calving or trauma *(Toussaint Raven et al., 1985; Greenough and Vermunt, 1991)*. The remaining lesions interdigital dermatitis (ID), heel horn erosions (HHE), interdigital hyperplasia (IH), interdigital phlegmone (IP) and digital dermatitis (DD) have an infectious origin. DD was maintained as a separate outcome and the lesions ID, HHE, IH and IP were aggregated as other infectious diseases (OID). The OID and DD lesions are associated with poor hygienic conditions and flooring system *(Somers et al., 2003).* Etiology and risk factors are comparable for the OID and DD diseases. Interdigital phlegmon (IP), an acutely painful infectious lesion that is likely to be treated at onset, rather than detected by a veterinarian, was also included in the category OID. Wound at interdigital skin (WD) and compound fracture of 3rd phalanx with septic podoarthritis (FR) were both recognized during examination by veterinarians. These lesions were accidentally occurred so they were mentioned in a separate aggregation, accidental lesions (AL) and were included in the dataset.

Out of the 1176 cows in this study, 414 (35.2%) were lame with at least one lesion. There were 39 diagnoses of DD (3.32%). The lesions of DD found mostly (27 cows) on the skin of the plantar aspect adjacent to the interdigital cleft. In nine cases, the lesion was found at the skin–horn junction of the heel bulbs. Only three cases had the lesion bordering the dorsal interdigital cleft of the fore feet. In an observational field study in 59 Dutch dairy herds, *Frankena et al. (1991)* reported a mean herd prevalence of about 15% of DD affections. More than 10 years later, the average prevalence rates for DD were estimated to be 21.6% *(Holzhauer et al., 2006)* in The Netherlands. In addition, *Hulek et al. (2010)* reported also that claw horn lesions were detected in 51 (25.6%) cows out of 199 examined cows and DD lesions were found in 24 cows on either one (n = 15) or both (n = 9) hind limbs. This constitutes a DD prevalence of 12.1% at 10 auction dates. In seven cows, the DD lesions were located on the left hind claws, in eight cattle on the right hind claws and in nine on both hind claws. All DD lesions were located on the plantar skin over the bulbs of the heels. In contrast to *Hulek et al. (2010)*, we intended to calculate the percentage of hoof lesions including DD in proportion to the total herd size not to the only examined lame cows to bring the actual prevalence in the herd.

In all DD affected cases in this study, cows had altered their posture and gait to avoid direct contact between the lesions and the floor due to pain, but *Berry (2001, 2006)* suggested that whereas herd lameness was higher in those herds with a high prevalence of digital dermatitis, not all affected cattle were lame and the size and maturity of digital dermatitis lesions may well have affected their association with lameness. Other authors have proposed that the severity of lameness is related to the severity of the clinical presentation of the lesion *(Leach et al., 1997)*, how long it has been present *(O'Callaghan et al., 2003)* and whether the lesion is infected *(Petersen and Nelson, 1984)*.

Nine cases (0.77%) of this study suffered from HHE. These cases were found in accompany with ID that might be due to extension of infection to the heel horn, and three cases developed fissures of heel horn. In contrast, the study of *Tadich et al. (2010)* revealed that the prevalence of HHE ranged between 40% and 55% of the examined cases according to locomotion score. They added that, the lesion presented in the form of pits and pockmarks, with parallel horizontal grooves on the bulb of the heel. Sometimes the horn is separated forming flaps.

Sixty cows (5.1%) in this study were affected with ID. The diagnosed ID cases were characterized by epidermal thickening and were often seen in the dorsal, plantar or palmar interdigital clefts. *Tadich et al. (2010)* described the ID lesions affected the cows in their study as inflammation of the interdigital skin without extension to deeper tissues. They also reported that the prevalence was 2% of the examined cows.

In this study, 9 cases (0.77% of total herd) of IP of the interdigital and digital tissues were seen in the form of symmetrical red and painful swelling of the foot. It caused severe lameness in the affected cows. Similarly, *Tadich et al. (2010)* found that interdigital purulent inflammation, with 4% prevalence, impacted significantly on cows' locomotion scores. They added that, the lesions were found in the form of acute necrotizing inflammation of the interdigital skin and underlying tissues, with swelling above the coronary band and in the interdigital space.

This study revealed 27 cases of IH (2.3% of total herd) in the form of epidermal vegetation of the interdigital skin. The outer claw of the hind leg was most affected (83%), where it started on a small skin fold close to the wall of the outer claw. In most cases (69%), it was associated with ID. similarly, *Tadich et al. (2010)* found that 2% of cattle with an interdigital hyperplasia in the form of fibrous proliferation of the interdigital skin causing a mass that protruded between the claws; which could be inflamed or not.

The prevalence of sole ulcer, in this study was 14.29% (168 cases). Affected cows showed different degrees of lameness in an effort to place more weight

on the medial claws. 11% of the affected cases with sole ulcer showed hemorrhage at the sole ulcer site without an open horn defect while 89% showed damage in the surface of the horn around the ulcer site. In the Netherlands, *Holzhauer et al. (2008)* reported that SU was present in 5.6% of the study population. They added that, 85% of the examined herds had one or more cows with SU cases, though the within-herd prevalence tended to be fairly small (between 1 and 5%). In addition, *Tadich et al. (2010)* found in their study that, with locomotion scores of 2 and 4 for cattle affected with sole ulcer, the respective figures of prevalence were 11% and 58% of the examined cows, indicating a closer association between the presence of sole ulcer and poorer locomotion. They defined the lesion as circumscribed loss of the horny sole exposing the corium of the solar surface, located in the region of the sole-bulb junction, usually nearer the axial margin with or without additional affection of deeper structures of the claw.

Seventy-five cases (6.38%) out of the total herd size were affected with SA. Most diagnosed cases (92%) were present in association with sole ulcers but in the minority of cases (6 cases, 8%), foreign body penetration was incriminated. The full thickness of the solar horn was found to be separated from the underlying solar corium and the space thus created was filled with pus. Pus was observed to be come out through a defect in the solar horn. Similar lesion was described by *Van Amstel and Shearer (2006).*

In this study, 35.2% of the total herd was lame with at least one lesion. The prevalence of claw lesions (51.59%) of primiparous cows was higher than that of multiparous cows (27.44%). The prevalence of all hoof lesions except sole abscess and fracture of the pedal bone was higher in primiparous than that of multiparous cows, while the prevalence of all aggregated lesions was higher in primiparous cows than multiparous ones. These results were in a disagreement with *Ettema et al. (2007)* who stated in their study that hoof lesions were diagnosed on as many as 80% of all cows in Danish dairy herds. Of these disorders infectious digital dermatitis (DD) was more prevalent in primiparous than multiparous cows, whereas the hoof lesions aggregated into OID were more prevalent in multiparous than primiparous cows. In our study the higher prevalence in primiparous cows might be attributed to the stress factors and physiological alteration impacted on the heifers during the 1st exposure to pregnancy and lactation. On the other hands, traumatic factors were incriminated in the causation of sole abscess and fracture of pedal bone in dairy cows regardless their reproductive status.

Amory et al. (2008) stated in their study that they can consider milk production before diagnosis as a predictor for lameness and reduction in milk production before diagnosis as a pre-diagnosis indication of lesion development or presence and milk production after diagnosis as a consequence of lameness and/or treatment. In our study, although we compared mean TDY between affected and unaffected cows we had noticed that the affected cows with SA and SU had a history of being the highest producers in the herd. This observation in addition to the highest prevalence of both SA and SU among recorded hoof lesions might explain the severe economic loss in the herds of this study. Most of the hoof lesions, in this study, had the affinity to affect the claws of the cows regardless their milk yield. Similarly, *Amory et al. (2008)* reported that, the high yielding cattle were more likely to develop non-infectious causes of lameness, SU, WLD (and possibly other types of lameness) but not apparently more likely to develop DD. They added that, high yielding cattle might be in the same physical environment as the average and low yielding cattle but might cope less well with this same environment. This could be because they have to behave differently, e.g., spend more time feeding, being milked and/or because they are genetically more susceptible within this same environment. Previously, *Grö hn et al. (1999)* reported that high yielding dairy cows are at a greater risk of metabolic disorders and this lack of physical robustness might also be a risk for horn-associated lameness, since metabolic disruption reduces hoof horn quality and pre-disposes to lameness *(Mulling et al., 1999)*. Similarly, DD and OID, in this study, had the ability to appear in the claws of any cows regardless their milk yield, as well as, the accidental lesions (wound of the interdigital skin and fracture of the pedal bone) that occurred when trauma and foreign body invade the claw. In addition, SA in this study was observed in highly producers because it was associated mainly with sole ulcer rather than being caused by foreign body trauma.

HHD in this study, was associated with significant decrease in TDY all over the lactation period, while, DD and OID were associated with significant decrease in TDY in the 2nd, 3rd, and 4th lactation stages. Accidental hoof lesions caused significant decrease in TDY before 100 DIM. SU in this study had the highest prevalence and it was also associated with significant decrease in TDY early in the 1st stage of lactation. DD did not appear in the examined lame heifers in the 1st stage of lactation. In general this study revealed that HHD represented the highest incidence and were associated with significant decrease in milk yield of highly producing cows allover the stages of lactation. These results were in agreement with *Warnick et al. (2001)*. Similarly the findings of *Amory et al. (2008)* suggested that DD and 'other' (referred to OID) lesions were less likely to be associated with metabolic dysfunction. These lesions were not associated with high initial yield or subsequent milk loss. In contrary, *Ettema et al. (2007)* found that, analysis of the association between OID and test-day yield has revealed an interesting pattern.

The association of an early diagnosis and treatment was either positive or less negative compared to a diagnosis and treatment in late lactation (201–305 DIM). The positive association of TDY with an early diagnosis of OID may indicate that high yielding cows are more susceptible to OID.

Mean TDY decreased significantly in cows suffered from fractured pedal bone and sole ulcer in the first lactation stage while, in the second lactation stage, significant decreases in TDY were recorded in cows, suffered from DD, SA, SU, ID and IH. In the third lactation stage, DD, SA, SU and ID were associated with significant decrease in TDY, while after 300 DIM, DD, SA, SU, ID, IH and IP were associated with significant decrease in TDY. The convenient treatment protocol for each lesion was initiated by the authors, as well as, the duty of the follow up was committed also to them in regular visits. The lameness did not disappear before at least two weeks from the start of treatment while the milk yield remained lower for up to 21 days. Fracture of the pedal bone with septic podarthritis, HHD and OID especially IP caused more delay in relief of lameness and recovery of the lowered TDY than did other lesions. Similarly, *Whay et al. (1998)* has demonstrated that cows those were lame with SU or WLD had a lowered pain threshold for up to 28 days after treatment, whilst those with acute digital tissue infection were not significant from unaffected cows following treatment. They added that it might be that the pain threshold was lower before as well as after treatment. OID and septic podarthritis accompanied the pedal bone fracture in this study as well as IP caused severe pain that might explain the delay in disappearance of the lameness and recovery of decreased milk yield in the affected cows. *Amory et al. (2008)* suggested that if milk yield was linked to pain then this might help explain continued decrease milk production in untreated cases. They added that one would anticipate that lack of treatment would have led to a continued fall in yield in line with the time before diagnosis and that treatment at least stabilized the reduced yields of these cows. In previous study, *El-Ghoul and Hofmann (2002)* suggested that milk production remained lower after treatment in cattle with SU or WLD. They suggested that, this might be associated with behavioral changes such as reduced feeding and drinking, due to increased pain or due to physiological changes, such as increased cortisol concentration and raised metabolic rate.

In primiparous cows of this study, there were significant decreases in mean TDY in cows suffered from OID in the 4th lactation stage, and cows that were diagnosed with OID produced approximately 15 kg less milk than unaffected cows in the 4th lactation stage. On the other hand, in the multiparous cows there were significant decreases in mean TDY in cows suffered from OID in the 2nd, 3rd and 4th lactation stages. Similarly, in the Study of *Ettema et al. (2007)*, more significant and stronger associations between OID and TDY were found in multiparous versus primiparous cows. This is consistent with more milk loss due to OID in multiparous than primiparous cows.

Primiparous cows with DD in this study did not produce significant decrease in mean TDY than unaffected cows, while multiparous cows that were diagnosed with DD showed significant decreases in TDY in the 3rd and 4th lactation stages. Similarly, A previous study by *Argaez-Rodriguez et al. (1997)* found a non-significant (P = 0.35) decrease in milk yield in DD affected cows. Conversely, *Ettema et al. (2007)* found that a diagnosis of DD early in lactation showed a negative association with TDY, whereas there was a positive, non significant association with a diagnosis later in lactation. These different associations between DD and test-day yield may be due to painfulness of DD. Studies on painfulness of hoof lesions found a lower nociceptive threshold for acute digital tissue infection *(Whay et al., 1998). Ettema et al. (2007)* added in their study that the negative association of DD diagnosed in early lactation on primiparous cows might be an indication of milk loss due to short term suffering of DD during peak lactation. The positive association, in their study, between DD and TDY in high yielding, multiparous cows and negative or no association in low or medium-yielding cows support the hypothesis that high milk yield is also a risk factor for DD.

In this study, there were significant decreases in mean TDY in primiparous cows suffered from SU in the 2nd and 4th lactation stages, while there were significant decreases in mean TDY in multiparous cows suffered from SA and SU all over the lactation stages. Similarly, *Hultgren et al. (2004)* reported a positive association between sole ulcer and milk yield, with an increased lactational yield. In contrary, *Ettema et al. (2007)* found that associations between TDY and severe sole haemorrhages were positive in the primiparous model, although not significant for the category of high yielding cows. They added that, with respect to SU, the positive association therefore was found for all primiparous cows. *Amory et al., (2008)* concluded that the change in milk production both before and after diagnosis indicates that lesion-specific lameness had varying effects on milk production.

Conclusions

Hoof lesions are a serious factor responsible for high economic loss in dairy industry. SU and SA have the highest prevalence among the hoof lesions in dairy farms. They are usually associated with the greatest milk loss in dairy cows as well.

High yielding dairy cows are more likely to expose to lameness due to SA and SU than average yielding or low yielding cows. DD, OID or accidental

hoof lesions (wound at interdigital skin and fracture of the pedal bone) can affect dairy cows regardless their milk yield.

Primiparous cows are more prone to be affected with higher prevalence of hoof lesions than multiparous cows due to physiological alteration associated with the first exposure to pregnancy and lactation in the former.

Corresponding author
Mohammed Hassan Shekidef
Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Suez Canal University. Ismailia, Egypt.
E-mail: shekidef77@vet.suez.edu.eg

5. References

Amory, J. R., Barker, Z. E., Wright, J. L., Mason, S. A., Blowey, R. W. and Green, L. E. (2008): Association between sole ulcer, white line disease and digital dermatitis and the milk yield of 1824 dairy cows on 30 dairy cow farms in England and Wales from February 2003-November 2006. Prev. Vet. Med., 83: 381-391.

Argaez-Rodriguez, F.J., Hird, D.W., Hernandez, J., Read, D.H. and Rodriguez-Lainz, A., (1997): Papillomatous digital dermatitis on a commercial dairy farm in Mexicali, Mexico: incidence and effect on reproduction and milk production. Prev. Vet. Med., 32: 275–286.

Barkema, H.W., Westrik, J.D., van Keulen, K.A.S., Schukken, Y.H. and Brand, A., (1994): The effects of lameness on reproductive performance, milk production and culling in Dutch dairy farms. Prev. Vet. Med., 20: 249–259.

Berry, S.L. (2001): Diseases of the digital soft tissues. Veterinary Clinics of North America: Food Animal Practice, 17: 129–142.

Berry, S.L. (2006): Infectious diseases of the Bovine claw. In Proceedings of the 14th International Symposium and 6th Conference on Lameness in Ruminants, Colonia, Uruguay, pp. 52–57.

Booth, C.J., Warnick, L.D., Grohn, Y.T., Maizon, D.O., Guard, C.L. and Janssen, D. (2004): Effect of lameness on culling of dairy cows. Journal of Dairy Science, 87:4115–4122.

Dohoo, I.R. and Martin, S.W., (1984): Disease, production and culling in Holstein-Friesian cows. IV. Effects of disease on production. Prev. Vet. Med., 2:755–770.

El-Ghoul, W. and Hofmann, W., (2002): Einfluss von klauenkrankheiten verschiedenen grades auf die hoher messbaren stressreaktionen unter besonderer berucksichtigung von cortisol und laktat im blutserum beim rind. Praktische Tierarzt., 83: 354–361.

Esslemont, R.J. and Kossaibati, M.A. (1997): Culling in 50 dairy herds in England. Veterinary Record, 139: 486–490.

Ettema, J. F., Capion, N. and Hill, A.E. (2007): The association of hoof lesions at claw trimming with test-day milk yield in Danish Holsteins. Prev. Vet. Med., 79: 224-243.

Ettema, J.F. and Østergaard, S., (2006): Modeling costs of lameness in dairy herds with representation of uncertainty in the state of nature. In: Proceedings of the 11th International Symposium on Veterinary Epidemiology and Economics.

Frankena, K., Stassen, E.N., Noordhuizen, J.P., Goelema, J.O., Schipper, J., Smelt, H., Romkema, H. (1991): Prevalence of lameness and risk indicators for dermatitis digitalis during pasturing and housing of dairy cattle. In: Proc. Ann. Symp. Soc. Vet. Epidemiol. Prev. Med., London, UK, pp. 107–118.

Green, L.E., Hedges, V.J., Schukken, Y.H., Blowey, R.W. and Packington, A.J., (2002): The impact of clinical lameness on the milk yield of dairy cows. J. Dairy Sci., 85: 2250–2256.

Greenough, P.R. and Vermunt, J.J., (1991): Evaluation of subclinical laminitis in a dairy herd and observations on associated nutritional and management factors. Vet. Rec., 128: 11–17.

Greenough, P.R. and Weaver, A.D., (1997): Lameness in Cattle, third ed. W.B. Saunders Co., London.

Gröhn, Y.T., McDermott, J.J., Schukken, Y.H., Hertl, J.A. and Eicker, S.W., (1999): Analysis of correlated continuous repeated observations: modelling the effect of ketosis on milk yield in dairy cows. Prev. Vet. Med., 39:137–153.

Hernandez, J., Shearer, J.K. and Webb, D.W., (2002): Effect of lameness on milk yield in dairy cows. J. Am. Vet. Med. Assoc., 220: 640–644.

Holzhauer M., Hardenberg C. and Bartels C.J.M. (2008): Herd and cow-level prevalence of sole ulcers in The Netherlands and associated-risk factors. Preventive Veterinary Medicine, 85: 125–135.

Holzhauer, M., Bartels, C.J.M., van den Borne, B.H.P. and van Schaik, G. (2006): Intra-class correlation attributable to claw trimmers scoring common hind-claw disorders in Dutch dairy herds. Prev. Vet. Med., 75: 47–55.

Hulek, M., Sommerfeld-Stur, I., and Kofler, J. (2010): Prevalence of digital dermatitis in first lactation cows assessed at breeding cattle auctions. The Veterinary Journal, 183: 161–165.

Hultgren, J., Manske, T. and Bergsten, C. (2004): Associations of sole ulcer at claw trimming with reproductive performance, udder health, milk yield, and culling in Swedish dairy cattle. Prev. Vet. Med., 62: 233–251.

Leach, K.A., Logue, D.N., Kempson, S.A., Offer, J.E., Ternent, H.E. and Randall, J.M., (1997): Claw lesions in dairy cattle: development of sole and white line haemorrhages during the first lactation. The Veterinary Journal, 154: 215–225.

Lischer, Ch.J., Ossent, P., Raber, M. and Geyer, H., (2002): Suspensory structures and supporting tissues of the third phalanx of cows and their relevance to the development of typical sole ulcers (rusterholz ulcers). Vet. Rec., 151: 694–698.

Mulling, C.K.W., Braguella, H.H., Reese, S., Budras, K.D. and Steinberg, W., (1999): How structures in bovine hoof epidermis are influenced by nutritional factors. Anat. Histol. Embryol., 28: 103–108.

O'Callaghan, K.A., Cripps, P.J., Downham, D.Y. and Murray, R.D. (2003): Subjective and objective assessment of pain and discomfort due to lameness in dairy cattle. Animal Welfare, 12: 605–610.

Petersen, G.C. and Nelson, D.R., (1984): Foot diseases in cattle, part II. Diagnosis and treatment. The Compendium on Continuing Education, 6: S565–S573.

Rowlands, G.J. and Lucey, S., (1986): Changes in milk yield in dairy cows associated with metabolic and reproductive disease and lameness. Prev. Vet. Med., 4:205–222.

Somers, J.G.C.J., Frankena, K., Noordhuizen-Stassen, E.N. and Metz, J.H.M. (2003): Prevalence of claw disorders in Dutch dairy cows exposed to several floor systems. J. Dairy Sci., 86: 2082–2093.

Tadich, N., Flor, E. and Green, L. (2010): Association between hoof lesions and locomotion score in 1098 unsound dairy cows. The Veterinary Journal, 184: 60-65.

Toussaint Raven, E., Halstra, R.T. and Peterse, D.J. (1985): Cattle Foot Care and Claw Trimming. Farming Press, Ipswich, United Kingdom.

Tranter, W.P. and Morris, R.S., (1991): A case study of lameness in three dairy herds. N.Z. Vet. J., 39: 88–96.

Van Amstel, S. R. and Shearer, J. (2006): Subsolar ulcer. In Manual for Treatment and Control of Lameness in Cattle. First edition, Blackwell Publishing, Professional 2121 State Avenue, Ames, Iowa 50014, USA. Pp 81-82.

Vermunt, J.J. and Greenough, P.R., (1994): Predisposing factors of laminitis in cattle. Br. Vet. J., 150:151–164.

Warnick, L.D., Janssen, D., Guard, C.L. and Gröhn, Y.T., (2001): The effects of lameness on milk production in dairy cows. J. Dairy Sci., 84: 1988–1997.

Whay, H.R., Waterman, A.E., Webster, A.J.F. and O'Brien, J.K., (1998): The influence of lesion type on the duration of hyperalgesia associated with hind limb lameness in dairy cattle. Vet. J., 156: 23–29.

4/22/2012